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August 10, 2012

Ed Randolph  
California Public Utilities Commission  
Energy Division Director  
505 Van Ness Avenue  
San Francisco, CA 94102

Re: Seismic Research Projects for San Onofre Nuclear Generating Station (SONGS)

Dear Mr. Randolph:

In accordance with Decision (D.) 12-05-004, Southern California Edison Company (SCE) respectfully submits for your review and comments the following SONGS seismic research project plans:

- 3D Deep Marine Seismic Reflection Survey
- Marine Terrace and Coastal Deformation Investigations
- Paleoseismic Trenching

Included is a revised Introduction with an updated "Table 1 – Seismic Research Projects Summary" and "Figure 1 – Schedule of Activities." SCE will submit plans for other research projects as SCE finalizes those plans.

Should you have any questions regarding this submittal, please feel free to contact me at 949-368-3540.

Sincerely,



Caroline McAndrews  
Director, Nuclear Strategic Projects  
San Onofre Nuclear Generating Station  
Southern California Edison

This document outlines Southern California Edison's (SCE) plans for performing the San Onofre Nuclear Generating Station (SONGS) Seismic Research Projects (i.e., geological, geodetic, and geophysical surveys). SCE developed these plans with the assistance of various agencies, academia, and consultants. The seismic research projects will provide new geologic and seismic information relevant to SONGS' tectonic and seismic setting.<sup>1</sup> This information will be obtained by conducting specific research that updates existing seismic source data.

The seismic research projects have been designed to capture the most relevant seismic source data, both in space and time, for the Newport-Inglewood/Rose Canyon Fault (NI/RC) and the "hypothesized Oceanside Blind Thrust" (OBT) Fault.<sup>2</sup> The NI/RC Fault is the controlling fault for SONGS and additional information is desired to better understand the existence and characteristics of the OBT Fault. Specifically, these projects will identify the level of activity and history of the NI/RC and OBT faults. For example, these projects will consider specific fault locations, geometries, fault types, slip rates, recurrence intervals, and potential earthquake magnitudes. The results from the onshore and offshore projects are intended to provide additional data concerning the seismic setting surrounding SONGS.

Not all seismic research projects have yet been planned, and for those that have been, short descriptions have been developed and are presented in Table 1. For those projects that have not yet been planned, only the descriptive title of the project is presented in Table 1. A summary schedule for the seismic research projects is provided in Figure 1. (Both Table 1 and Figure 1 revised 8/10/12.)

#### Project Management

SCE is managing the project and coordinating with a number of agencies, academia, and consultants to initiate and complete the seismic research projects.

#### Project Support

Each project is supported by a mix of the following agencies, academia, and consultants:

- |   |   |
|---|---|
| • GeoPentech                              | • GEOVision (onshore 3D)                    |
| • Padre (permits)                         | • Earth Consultants International (onshore) |
| • Lamont Doherty Earth Observatory        | • SDSU (paleoseismic)                       |
| • GeoTrace (geophysical data processing)  | • UNAVCO (GPS)                              |
| • NodalSeismic (geophone data collection) | • Scripps (seismology)                      |

Offshore Technical Leaders include:

- |                          |                         |
|--------------------------|-------------------------|
| • Neal Driscoll, Scripps | • Graham Kent, UNR      |
| • Peter Shearer, Scripps | • Frank Vernon, Scripps |
| • Steve Wesnousky, UNR   |                         |

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<sup>1</sup> Seismic setting is defined as the identification of credible earthquake sources by studying past earthquake activity recorded by local surface and subsurface structures.

<sup>2</sup> The existence of the OBT Fault is unknown and further research is required.

Offshore Peer Review from, as available:

- Holly Ryan, USGS
- John Shaw, Harvard
- Mark Legg, Legg Geophysical
- Christopher Sorlien, UCSB

Onshore Technical Leaders include:

- Tom Rockwell, SDSU
- Lisa Grant Ludwig, UCI
- Frank Vernon, Scripps
- Karl Mueller, University of Colorado
- Ray Weldon, University of Oregon
- Peter Shearer, Scripps

Onshore Peer Review from, as available:

- James Dolan, USC
- Kathryn Hanson, AMEC
- Dan Ponti, USGS
- Roy Shlemon, Private Consultant



**Table 1 – Seismic Research Projects Summary**

Project #	Project	Project Description
1	Historical Marine Geophysical Data Reprocessing and Reanalysis	<p>This project will update seismic source data within the area of interest associated with the NI/RC and OBT faults by reprocessing and reanalyzing existing seismic reflection data collected by SCE, USGS, the petroleum industry, and academia.</p> <p>The data will be used to optimize the planning of future marine geophysical surveys in focused areas and depths within the area of interest associated with the NI/RC and OBT faults. The data will support the environmental permitting processes for those projects.</p>
2	2D Deep Marine Seismic Reflection Survey	<p>This project will collect and process 2D deep marine multi-channel seismic and other geophysical data for the area that encompasses the portion of the Newport-Inglewood/Rose Canyon (NI/RC) Fault relevant to the seismic setting surrounding SONGS, and its potential intersection with the OBT Fault.</p> <p>The data will be used to evaluate the location and geometry of the potential intersection of the NI/RC Fault and OBT Fault in the area offshore of SONGS, unless the contrast between the faults and the flanking bedrock does not facilitate imaging with modern marine geophysical methods.</p> <p>The portion of the deep marine geophysical data west of this potential fault intersection, or above the bedrock, will be used to define potential rupture area parameters for the NI/RC and OBT faults.</p> <p>The data will support evaluation of deep geologic stratigraphy, folding, and faulting below the ridges and basins defined by the bathymetry. The data may also establish the seismic velocity parameters in the underlying geologic materials, which support interpretation of the resulting marine geophysical data and establish locations and depths of offshore earthquakes.</p>
3	GPS Monitoring	<p>This project will install and monitor continuous GPS stations in the region surrounding SONGS to observe crustal deformation patterns and regional strain accumulation.</p> <p>The data will be used to evaluate slip rates and activity of the NI/RC and OBT faults.</p>

**Table 1 – Seismic Research Projects Summary (Continued)**

Project #	Project	Project Description	
4	3D Deep Marine Seismic Reflection Survey	This project will collect and process 3D deep data across the intersection of the NI/RC and OBT faults similar to the 2D Deep Marine Seismic Reflection Survey project.	
5	2D Shallow Marine Seismic Reflection Surveys	To be provided in a future submittal.	
6	3D Shallow Marine Seismic Reflection Surveys	To be provided in a future submittal.	
7	Seafloor Surveys	To be provided in a future submittal.	
8	Sea Floor Sediment Sampling and Age Dating	To be provided in a future submittal.	
9	Onshore and Offshore USGS CRADA Investigations	To be provided in a future submittal.	
10	Marine Terrace and Coastal Deformation Investigations	This project will collect and process marine terrace data related to the vertical deformation along the southern Orange County and northern San Diego County coastline and the amount of vertical deformation contributed by the NI/RC Fault and the OBT Fault.	
11	Paleoseismic Trenching	This project will excavate trenches across the Rose Canyon segment of the NI/RC Fault in San Diego County to measure fault displacement and establish fault history directly from the fault zone.	
12	Seismic Monitoring	Onshore	To be provided in a future submittal.
		Offshore	To be provided in a future submittal.



Figure 1 – Schedule of Activities

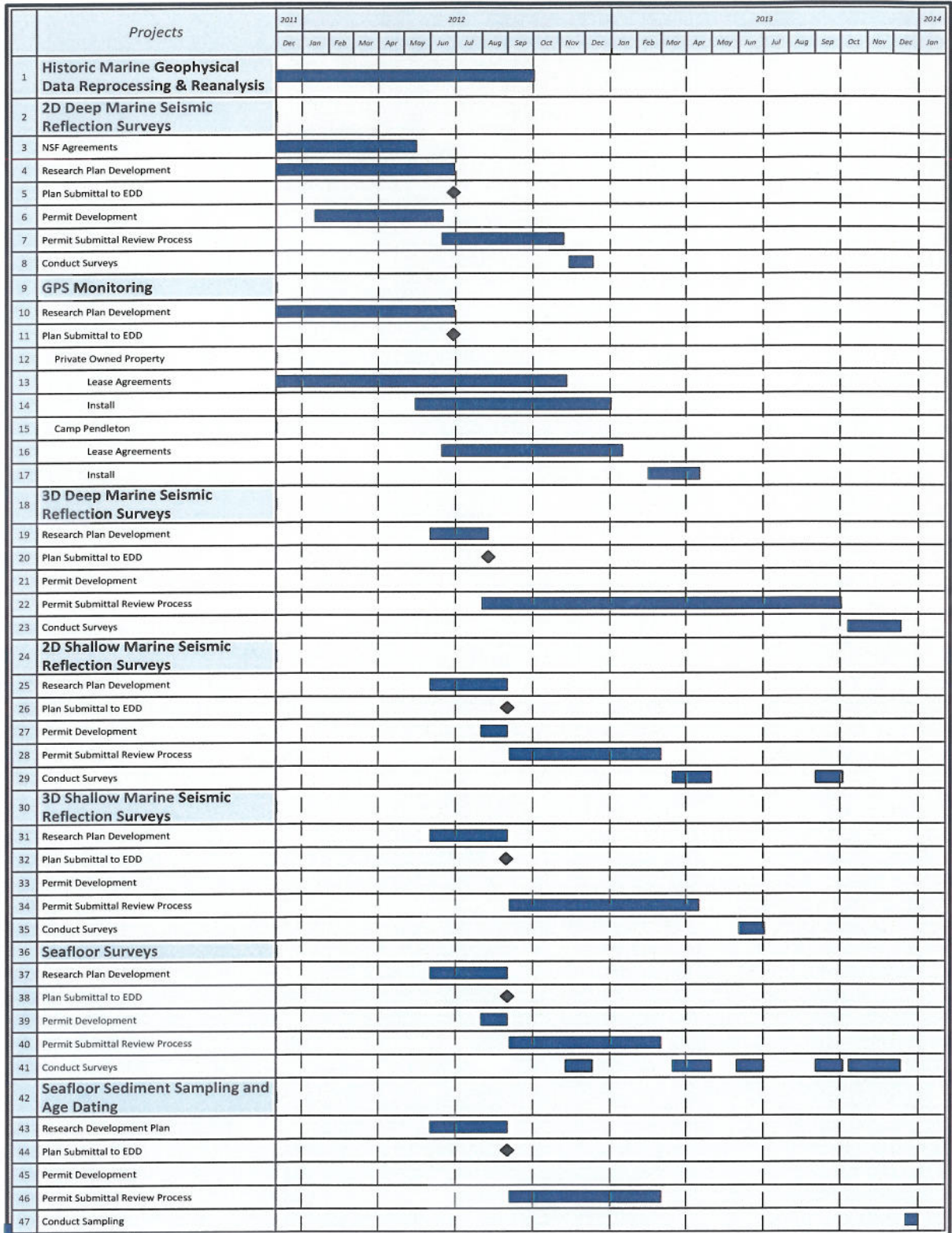
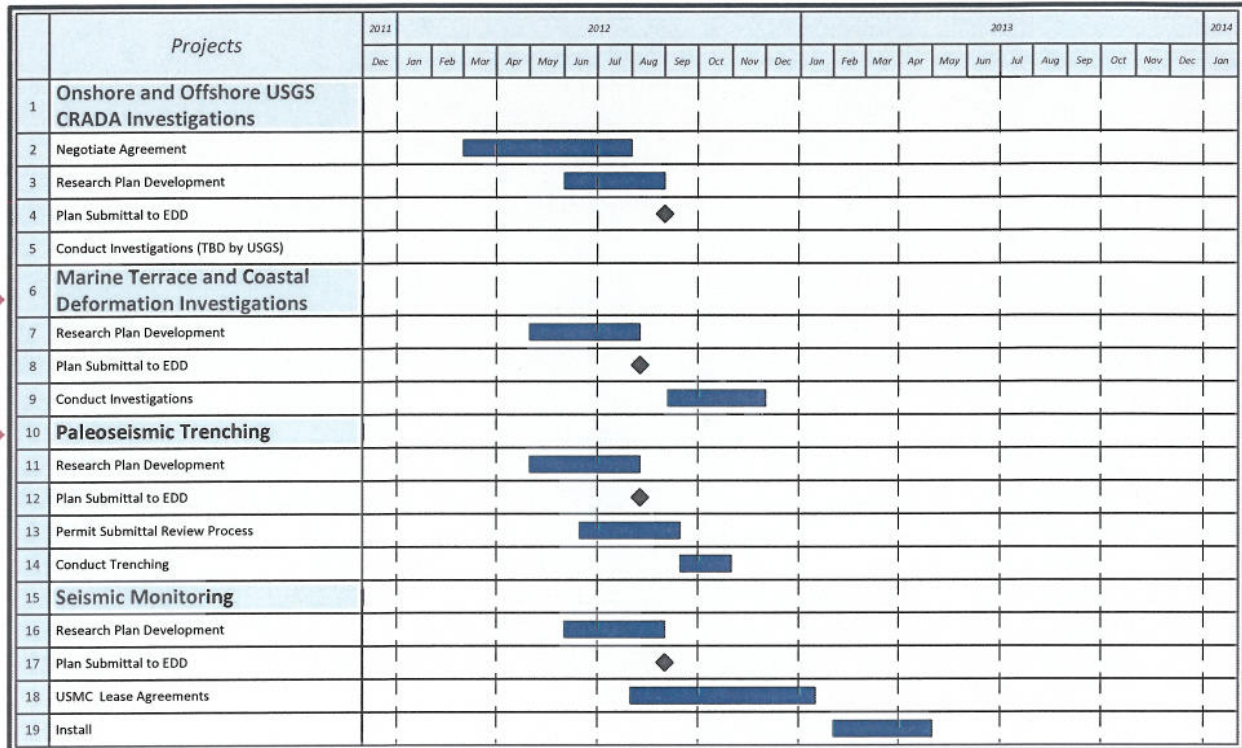


Figure 1 – Schedule of Activities (Continued)



## Objective

Collect and process 3D deep data across the intersection of the Newport Inglewood/Rose Canyon (NI/RC) and the Oceanside Blind Thrust<sup>1</sup> (OBT) faults.

## Scope of Work

This project<sup>2</sup> includes the following activities:

1. Obtain necessary permits to conduct 3D deep survey.
2. Determine the target area.
3. Collect 3D deep data and perform quality assurance/quality control (QA/QC) on the acquired raw field data.
4. Process the 3D deep data.

### 1. Obtain 3D deep survey permits

The time needed to obtain state water permits requires the use of existing information to establish the survey target area. An example of the size of the area that will be imaged by this project (40 km by 25 km) is shown in Figure 1. The actual location of the 3D deep survey will be determined by the new 2D deep data. The following permits will be secured:

- An Incidental Harassment Authorization (IHA) by the National Marine Fisheries Service (NMFS) will be required due to the potential impacts to marine species. Approval of an IHA is required for compliance with the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA).
- Review of the federal permits by the California Coastal Commission (CCC) will be required under the Coastal Zone Management Act (CZMA).
- A Coastal Development Permit (CDP), issued by CCC, is required for work within state waters.
- A California State Lands Commission (CSLC) permit is required as part of the California Environmental Quality Act (CEQA) process.

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<sup>1</sup> The existence of the OBT Fault is unknown and further research is required.

<sup>2</sup> A.11-04-006, Deep 2D/3D Marine Seismic Reflection Mapping (2D provided with first submittal).



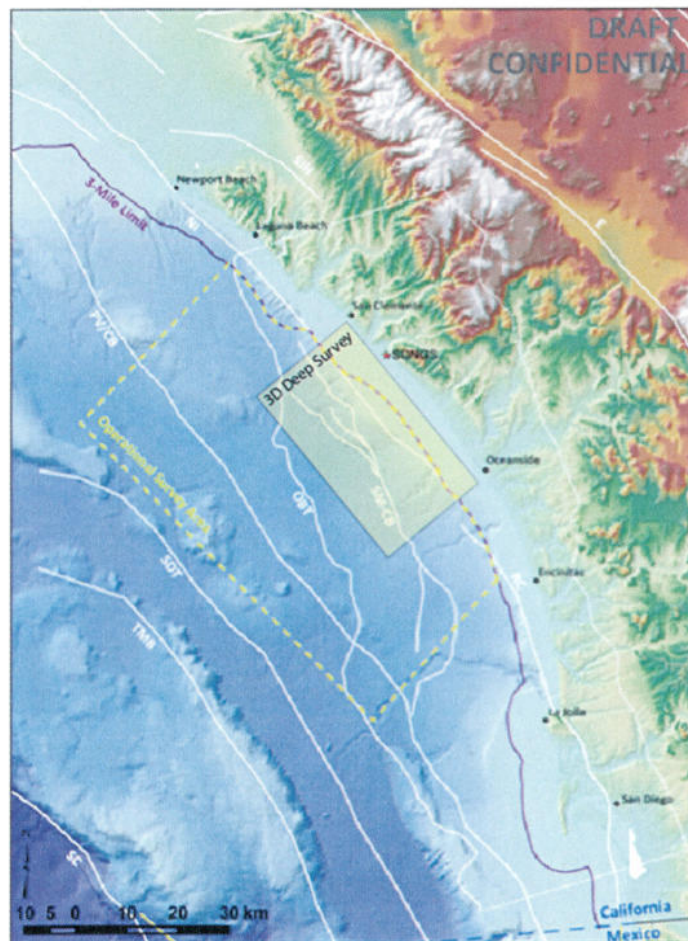


Figure 1. Green shaded box shows a 40 km by 25 km area that will be imaged during 3D deep seismic mapping. The location of the survey area and the size of the survey will be modified contingent on the results derived from the 2D deep survey.

## 2. Determine the target area

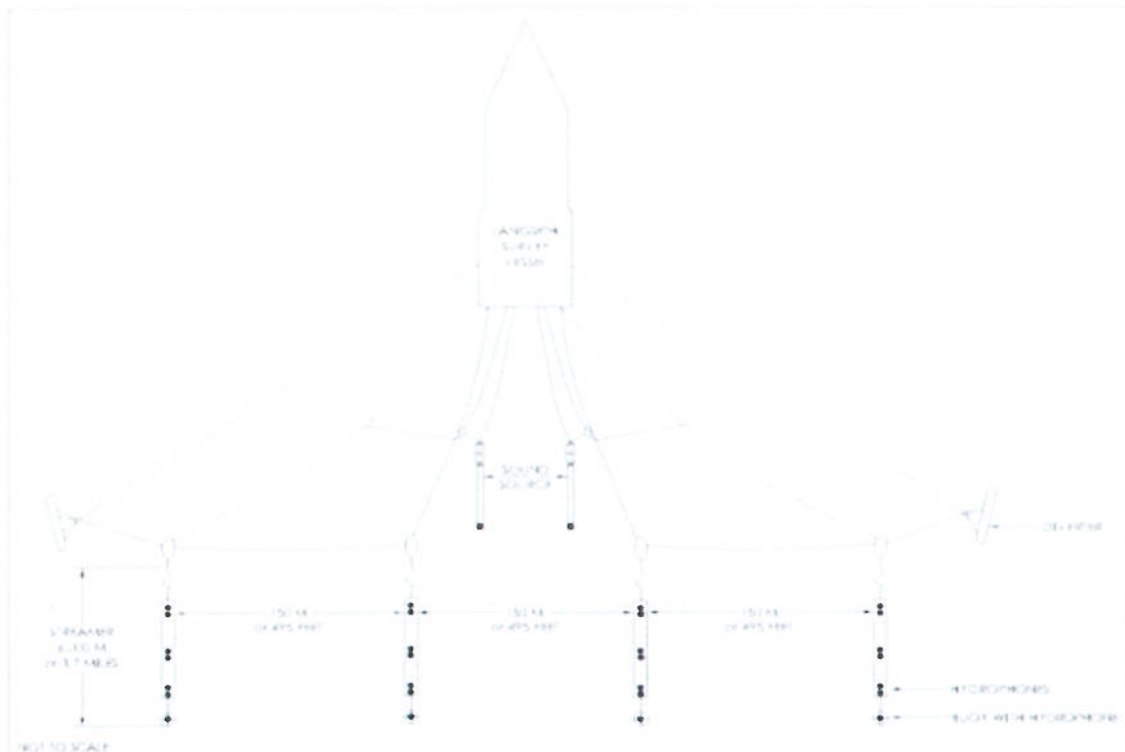
Based on previous ground motion and fault studies, members of the Offshore Technical Leader Team<sup>3</sup> defined the size of the 3D survey area. This survey area was then reviewed by an Offshore Peer Review Team.<sup>4</sup> The actual location of the 3D deep survey will be determined by the new 2D deep data. As stated in the 2D Deep Marine Seismic Reflection Surveys project, the results from the 2D deep survey may indicate that a 3D deep survey is not warranted.

<sup>3</sup> Graham Kent, UNR; Neal Driscoll, Scripps.

<sup>4</sup> John Shaw, Harvard; Holly Ryan, USGS; Mark Legg, Legg Geophysical; Christopher Sorlien, UCSB.

### 3. Collect 3D deep data

The 3D deep survey acquires geometric images of subseafloor structures and is designed to minimize out-of-plane artifacts. Minimization of out-of-plane artifacts is accomplished by multiple streamers, as shown in Figure 2, and closely spaced track-lines.<sup>5</sup> This project will be performed if the intersection of the NI/RC and OBT faults can be imaged in the 2D deep data.



**Figure 2. Schematic showing the dual string air gun arrays and four 6-kilometer-long streamers.**

GeoTrace (an industry geophysical processing company based in Houston, TX) is involved in survey design and will participate on the cruise to ensure data quality and that the proposed targets will be imaged properly. Data QA/QC will be performed in real time on the vessel. Following the cruise, GeoTrace will process the 3D deep data.

### 4. Process Data

The raw acquired 3D deep data will be processed to remove artifacts and increase signal-to-noise.

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<sup>5</sup> Track-lines are defined by the path of the ship while collecting data.

### Prerequisites

- Required permits, stated above, have been secured.
- *R/V Langseth* (or similar industry vessel) and *R/V Sproul* must be available.
- Complete *2D Deep Marine Seismic Reflection Surveys* project.
- Surveys need to occur during certain time periods to mitigate environmental impacts (optimal window is October and November).

### Project Risks with Mitigation Plans

- Due to weather, mammal migration season, or other unforeseen events, the 3D deep survey may not be completed. Mitigation: Perform survey during another period.
- Environmental incidents may occur while collecting seismic reflection data using large vessels and seismic sources. Mitigation: Exercise policies developed by permitting agencies.
- The *R/V Langseth* (or similar industry vessel) may not be available. Mitigation: It may be possible to schedule a private industry vessel at a significantly higher cost.
- State environmental permits may be delayed. Mitigation: The survey schedule may need to be delayed or the 3D deep survey may only be performed within federal waters.

### Specific Deliverables

- Digital raw and processed 3D deep data.



### Objective

Collect marine terrace data related to the vertical displacement along the southern Orange County and northern San Diego County coastline for use in assessing vertical deformation contributed by the Newport Inglewood/Rose Canyon (NI/RC) Fault and the Oceanside Blind Thrust (OBT) Fault.<sup>1</sup>

### Scope of Work

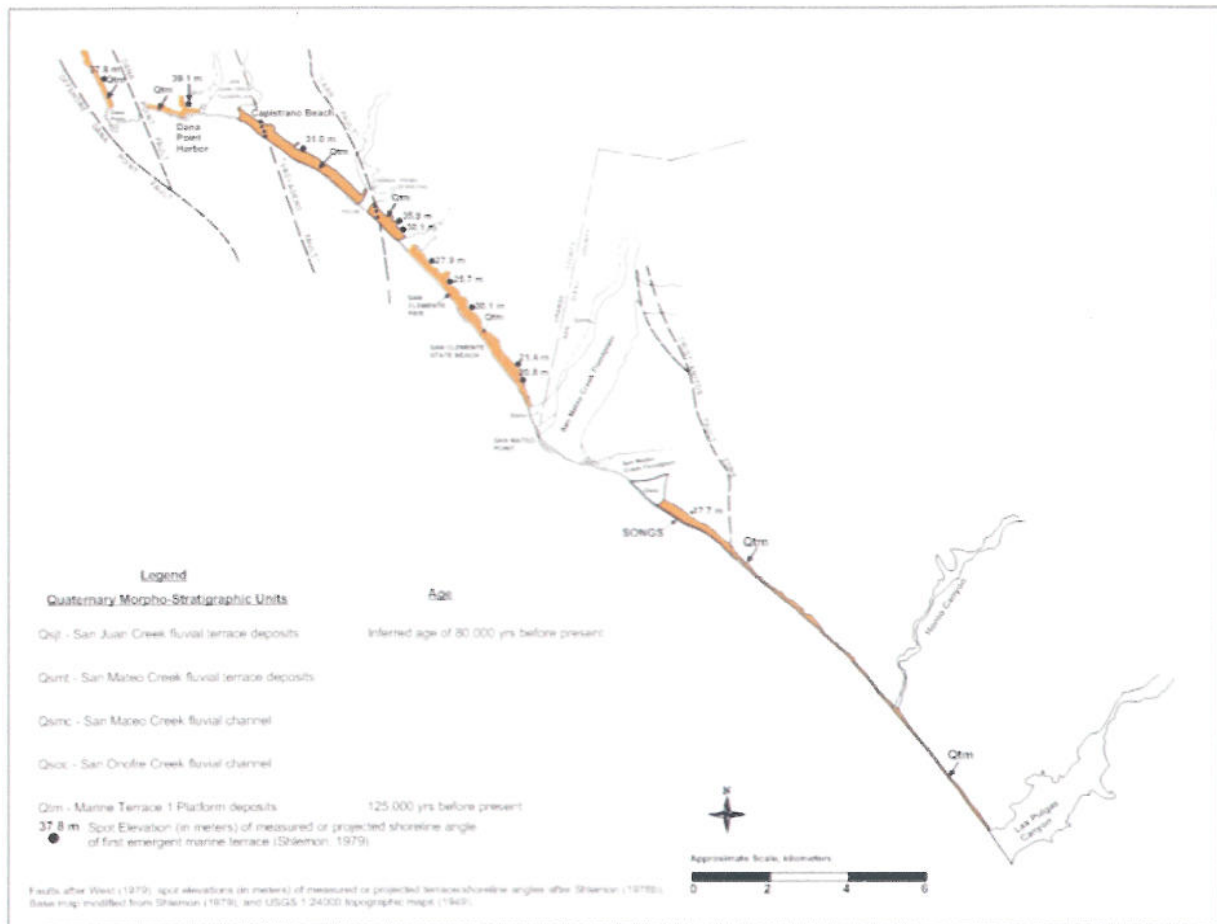
This project<sup>2</sup> includes the following activities:

1. Collate existing marine terrace data and perform additional terrace mapping and dating where necessary to fill in data gaps using modern techniques. Figure 1 shows available data and areas where additional data is needed. Data types that will be acquired include aerial photo analyses, mapping, terrain profile measurement collection, and age date sample collection.
2. Use the collated data along with newly acquired data to determine the tectonic/seismic vertical elevation changes of the different aged marine terraces relative to past sea levels to evaluate the vertical components of folding and faulting associated with displacements on the NI/RC and OBT faults.
3. Use national data sets (NOAA tide gauge data and NGS geodetic surveys) to estimate the vertical movement of the coastline surrounding SONGS and compare these estimates to vertical movements derived from geologic data. This assessment will provide an additional dataset to examine the short-term vertical movements of the NI/RC and OBT faults.

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<sup>1</sup> The existence of the OBT Fault is unknown and further research is required.

<sup>2</sup> A.11-04-006, Onshore Studies.



**Figure 1. Existing marine terrace data in the area surrounding SONGS. New data collection will extend south from SONGS through Camp Pendleton Marine Corps Base**

Marine terraces provide information on relative and absolute uplift of the coastline. Quantifying the age and elevation of the marine terrace near SONGS may define the deformation rates in the area around SONGS.

This project is being conducted to acquire elevation and age dates for the coastal terraces along the OBT Fault and the offshore portion of the NI/RC Fault. Figure 2 shows marine terraces and associated features that will be measured and sampled during this project. This project may provide an additional dataset to examine the short-term vertical movements of the NI/RC and OBT faults, and information on whether the coastal uplift and subsidence is due to seismic or aseismic processes.

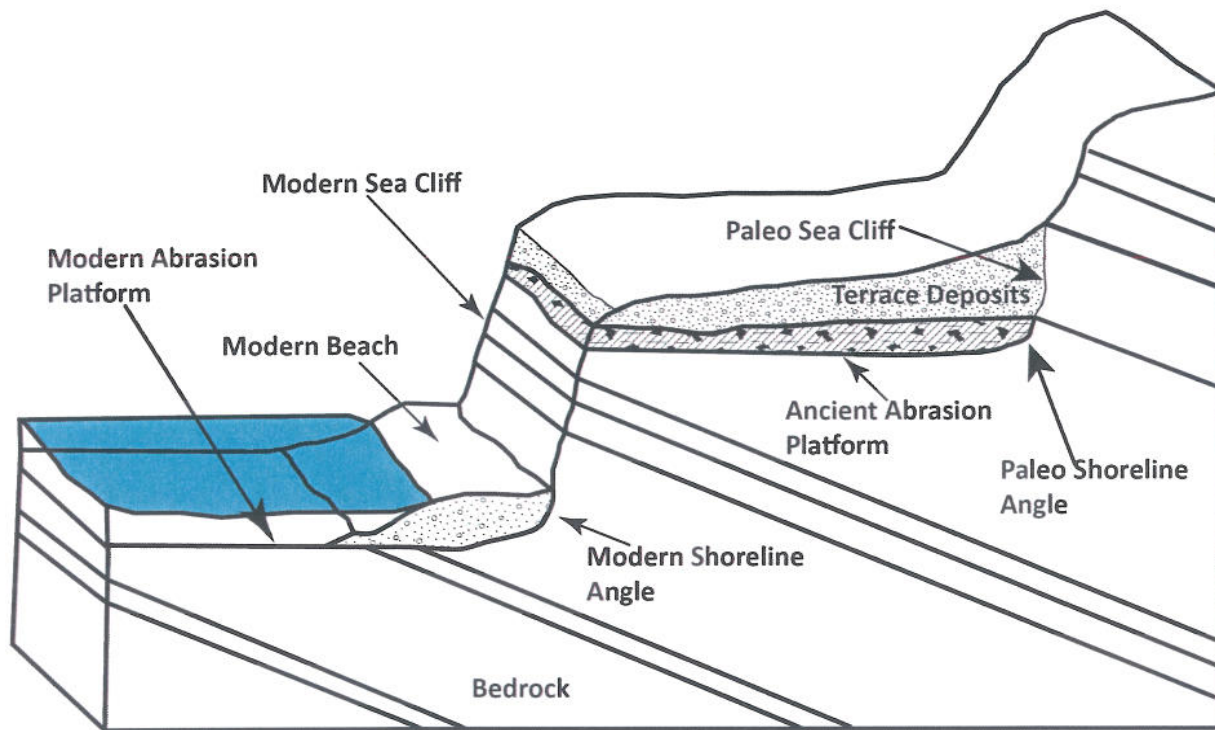


Figure 2. Diagram of modern and paleo marine terraces and associated features

### Prerequisites

Access to other potential sites, in addition to Camp Pendleton, may be needed and may require environmental permits to obtain terrain profile measurement and age date samples.

### Project Risks with Mitigation Plans

Delays due to military operations on Camp Pendleton. Mitigation: Adjust work schedule to accommodate.

### Deliverable

Final report providing vertical movements of the coastline surrounding SONGS.



## Objective

Excavate trenches across the Rose Canyon segment of the Newport-Inglewood/Rose Canyon (NI/RC) Fault in San Diego County to measure fault displacement and establish fault history directly from the fault zone.

## Scope of Work

This project<sup>1</sup> will include the following activities:

1. Identify potential trench sites.
2. Excavate the trenches and obtain geologic measurements and material for age dating from the fault zone. Restore sites to land owner's acceptance.

This project will provide displacement and age dating information for the NI/RC Fault.

### 1. Identification of potential trench sites

Trench sites are selected in San Diego county where the NI/RC Fault comes on shore and are based on a review of old aerial photographs in comparison with new aerial digital images where fault structures are observed.

### 2. Excavate trench sites to obtain geologic measurements and obtain material for age dating

Paleoseismic data are obtained through direct geologic measurements of displaced sedimentary features across the fault. Samples are collected and dated, which provide age information on the fault history. At these sites, two to three trenches across and one parallel to the NI/RC Fault will be excavated to characterize the three-dimensional geologic setting.

## Prerequisites

The following encroachment permit applications are required:

- Caltrans for trenching at the Interstate 5 and 52 intersection
- City of San Diego for trenching at the Presidio Golf Course

## Project Risks with Mitigation Plans

- Access permission is not received or is delayed because of environmental or archaeological concerns. Mitigation: Collaborate with Caltrans and the City of San Diego to mitigate environmental and archaeological concerns by avoidance.
- Sediments in excavated trenches do not provide the necessary data to establish slip rates or recurrence intervals. Mitigation: Stop trenching activities.

## Specific Deliverables

- Report on displacement and age dating for the NI/RC Fault.

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<sup>1</sup> A.11-04-006, Onshore Studies.